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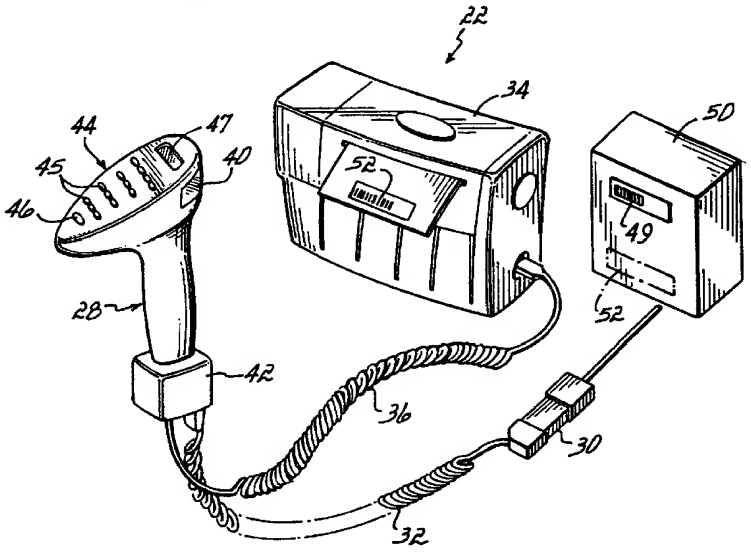

(57) Abstract: A monitoring and tracking system (20) is comprised of a hand-held data collector (22) having a sensor (30), for example, a temperature sensor, a reader (40), for example, a bar code scanner, a user I/O device (44) and a transceiver unit (42) in electrical communication with a data processor (38). The data processor receives information from the sensor and the reader; and the data collector transmits that information over a communication link (26) to a computer where the data is analyzed and stored. In a food processing facility, the above monitoring and tracking system may be used to monitor, track, analyze and provide a real time reporting of temperatures and locations of specific food items in inventory. Each time the food location is changed, a new expiration date for the food item is automatically calculated and applied to a new food rotation label. Further, the history of food items from a manufacturer's food lot number can be quickly reported.

WO 01/27577 A2

MONITORING AND TRACKING SYSTEM AND METHOD

This application claims the benefit of U.S. Application Serial No. 09/573,764, entitled "Monitoring and Tracking System and Method, filed on May 18, 2000 and U.S. Provisional Application No. 60/178,056, entitled, "Inventory and Temperature Tracking System", filed on January 24, 2000 and U.S. Provisional Application No. 60/158,785, entitled, "Inventory and Temperature Tracking System", filed on October 12, 1999; the entire disclosures of which are hereby incorporated by reference herein.

Field of the Invention

The present invention generally relates to monitoring systems and more particularly, to a monitoring and tracking system normally used in the food industry.

Background of the Invention

Food processing, serving, storing, transportation and warehousing facilities must be constantly vigilant of the temperature of the food being handled. Food temperature specifications are recommended for the cold storage, cooking and warming of food. Further, there are recommended specifications for the maximum time periods for which foods can be kept at temperatures other than the recommended temperatures. Such temperature specifications also determine the longest period of time that can be used to raise or lower the temperature of food between recommended temperatures. Failure to maintain food at the proper temperature often results in loss of desired texture and taste, spoilage and/or food born illness which requires more labor, special handling and adds inefficiencies and cost to food handling, preparation and serving processes.

Thus, the handling of food requires a constant monitoring of its temperature and/or the temperature of the ambient air in which the food is being stored, for example, cold storage air temperature. The collection and maintenance of temperature data is accomplished using various instruments and is generally very labor intensive. There are known devices for measuring temperatures and automatically recording those temperatures on a paper chart; however, such devices have relatively limited applications.

It is also known to use inspectors who carry portable temperature data collection devices that include a temperature measuring sensor and a data storage device, for example, a digital processor with memory that maintains a digital record of the temperatures measured. The inspectors use the temperature sensor to measure the temperature of the food at different times and at different stages of the food handling, preparation and serving processes. Historical temperature records are kept either manually or are entered into a computer for storage and

reporting. Recommended temperatures in food handling and preparation processes are set forth in an FDA Model Food Code. While the Food Code provides a recommended temperature model, it does not specify any implementation of the model. One widely used implementation of the Food Code model is an HACCP (Hazard Analysis and Critical Control Points) analysis. The exact implementation of an HACCP analysis will vary from user to user depending of the nature of the food items, the size of the facility, etc. However, any implementation of an HACCP analysis and associated data collection is very labor intensive and prone to errors. Thus, there is a need for a convenient method and system for tracking temperatures of food items at different locations and providing a historical temperature record of the food item.

Known temperature measuring systems only measure and maintain a record of the temperature at a location, for example, a cooler, cooking station, serving station, etc.; and there is no association of the measured temperature with specific food items being stored, prepared and/or served. However, in every food handling and food processing facility, it is necessary to keep track of the shelf life of each food item in inventory; and the food items must be rotated or used so that the oldest food items are used before they exceed their recommended shelf life. Further, the shelf life of a food item is a variable that is constantly changing as the food item moves through a food handling and processing facility. Food items are normally identified as food types, for example, meats, dairy products, frozen vegetables, fresh fruits, cooked foods, etc. Further, the food items are initially located in a freezer, a deep chiller, a refrigerator, dry storage, etc.; and thus, each food item has an initial shelf life depending on its type and initial location. However, the shelf life of a food item changes as it moves through a food processing facility. For example, a diary product is often received in a deep chiller and has a shelf life in the chiller of 15 days. If after 10 days, the dairy product is moved to a refrigerator; it's shelf life will change. For example, a dairy product has a shelf life of 10 days in a refrigerator. However, after 10 days in the deep chiller, this dairy product only has 5 days of shelf life left; and therefore, only has five days of shelf life available in the refrigerator. Therefore, this dairy product has an expiration date that is five days after the date that it is placed in the refrigerator; and if it is not consumed by the expiration date, it must be discarded as spoiled. Thus, as can be appreciated, tracking the shelf life and expiration dates of all of the food items in a food handling and processing facility is a substantial undertaking.

Currently, such tracking is done manually, and most often, as food is moved through the food handling and processing facility, the expiration dates are recalculated and handwritten on a label which is applied to the package or container of the food item. As will be appreciated, any operation that is so labor intensive often results in errors, and loss of food due to exceeded expiration dates is relatively common. Therefore, there is a need for a convenient

method of automatically tracking shelf lives and expiration dates of food items as they move to different locations in a food handling and processing facility.

Occasionally, a manufacturer of a food item discovers that the food item was tainted during a manufacturing process, and the manufacturer then issues a recall of all food items that were manufactured in the same lot as the tainted food item sample. Normally, all of the food items manufactured in the same lot will share a common lot number. Hence, the manufacturer's recall will refer to a lot number that is reproduced on the packaging of the food item. A food handling and processing facility normally does not record such lot numbers. Hence, if a recall notice is issued, the food handling and processing facility undertakes a manual inspection of all related food item packages to determine whether any food items with the recalled lot number are in inventory. If so, the food items are removed from inventory. If not, it is assumed that the food items from the recalled lot number were either not received or were consumed. Thus, if the food handling and processing facility experiences complaints with respect to its prepared and consumed food, it has no way of verifying whether the food items used came from the recalled lot. Thus, there is a need for a convenient way of determining whether food items associated with different lot numbers were ever received by a food handling and processing facility. Further, if food items from a recalled lot were received and used and complaints are received, there is a need for a convenient way of determining when, and in what recipes, the food items from a recalled lot were consumed. Thus, there is a need for a single, integrated system that tracks food items, temperatures, expiration dates and lot numbers as the food items are handled throughout a food preparation and consumption process.

While the monitoring and tracking of temperature with respect to individual food items is important in a food making and handling facility, the monitoring and tracking of a processing activity is also important. Whether making food for packaging and then resale or making food to be immediately served, consistent processing of the food in accordance with a desired recipe and accepted trade practice is absolutely necessary in order to provide a consistently high quality product. Currently in a typical restaurant environment, food processing often requires the use of different food processing appliances or devices, for example, mixers, cookers, fryers, coolers, etc. Further, many of those appliances are designed to cook a particular food and have automatic cycles of operation for that purpose. However, there are still conditions that must be monitored and actions taken to maintain the desired quality of cooked food. For example, the level of cooking oil in a fryer should be checked, and the type of food and number of cooking cycles determines when the cooking oil should be changed. Thus, the fryer and other food processing appliances often require some ongoing attention and maintenance by food preparers who are under pressure to prepare food quickly. Given the often frantic level of activity in a commercial kitchen and the fact that the food processing devices are being operated by

different persons, it is easy for the details of ongoing maintenance associated with food processing appliances to be missed. There is a further need for a system that monitors and tracks the ongoing operation of food processing devices in order to facilitate their proper operation.

Summary of Invention

The present invention provides a monitoring and tracking system that permits a user to have accurate and immediate access to a reporting of all of current inventory, its history and current shelf life. If the inventory is temperature sensitive, the monitoring and tracking system of the present invention permits temperature readings to be easily taken and stored. Measured temperatures that are out of a desired range are immediately reported so that corrective action may be taken. The monitoring and tracking system of the present invention is very flexible and can be structured to any user's needs. Further, with the monitoring and tracking system of the present system, product rotation is optimized so that product spoilage can be virtually eliminated. Thus, with more efficient use of the products in inventory, operating costs can be substantially reduced. The monitoring and tracking system of the present invention is especially useful in the food industry.

In accordance with the principles of the present invention and the described embodiments, the invention provides a hand-held data collector having a sensor, for example, a temperature sensor, a reader, for example, a bar code scanner, a user I/O device, a data processor in electrical communication with the sensor, the reader and the user I/O device, and a transceiver unit in electrical communication with the data processor, the data processor receiving information from the sensor and the reader. Thus, with a single portable, hand-held device, a user can, anywhere in a facility, read a bar code on a food package and measure the temperature of the food package. In one aspect of this embodiment of the invention, the data collector can be connected to a printer, for example, a bar code label printer, so that a new food package label can be printed.

In another embodiment of the invention, the above data collector is connected to a computer via a communications link. Thus, the measured temperature and bar code information are transferred to the computer for analysis and storage. In one aspect of this embodiment, the communications link includes a wireless communications link with the data collector.

A further embodiment of the invention provides a method of tracking temperatures of a food item in which identity data identifying the food item is created and a temperature value of the food item is measured with a temperature measuring device. Next, the temperature value of the food item is transmitted to a computer and stored in association with the

identity data, so that a record of the temperature of the food item is maintained. In one aspect of this invention, the temperature of the food item is measured with a hand-held data collector. Thus, the monitoring and tracking system of the present invention has the advantages of continuously, very accurately and reliably monitoring and tracking temperatures in association with a food item which heretofore was only performed manually.

In a still further embodiment of the invention, a method is provided for monitoring and tracking shelf life for a food item by providing identity data identifying a food item, identifying a first location of the food item, and automatically determining a shelf life for the food item as a function of the identity of the first location. In one aspect of this embodiment, the method determines a first date on which the food item is placed at the first location, and then, automatically determines a first expiration date for the food item as a function of the identity of the first location and the first date. Thus, the method permits food rotation to be optimized, so that ingredients with the oldest expiration dates can be accurately and quickly found and spoilage of food in inventory can be eliminated. Further, the present invention permits new product rotation labels to be accurately and quickly printed on the floor at the location where the label is to be applied. Further, such labels include all pertinent information in coded as well as human readable form so that the information on the label can be accurately and quickly entered into the system by a scanning process.

In yet another embodiment of the invention, a method of monitoring and tracking a food lot number for a food item is provided that first provides and stores, in a monitoring and tracking system, identity data identifying food items and food lot numbers associated with respective ones of the food items. Each food lot number identifies a specific lot from which the food item was made by a particular manufacturer. The method next generates a report using the monitoring and tracking system to identify the food items associated with a lot number input by a user. Thus, the system has the advantage of accurately and quickly being able to identify recalled food items as well as accurately verify whether complaints correspond to the use of recalled food items in specific recipes on specific days. Thus, any such complaints can be expeditiously handled with a high level of confidence and certainty.

Various additional advantages, objects and features of the invention will become more readily apparent to those of ordinary skill in the art upon consideration of the following detailed description of the presently preferred embodiments taken in conjunction with the accompanying drawings.

Brief Description of Drawings

Fig. 1 is a schematic block diagram of a portable, hand-held data collection system in accordance with the principles of the present invention.

Fig. 2 is perspective view of the portable, hand-held data collector used in the system of Fig. 1.

Fig. 3 is a flow chart illustrating a process for using the monitoring and tracking system in accordance with the principles of the present invention.

Fig. 4 is a schematic showing of a product list table similar to one maintained by the monitoring and tracking system of Fig. 1.

Fig. 5 is a schematic showing of a food inventory table similar to one maintained by the monitoring and tracking system of Fig. 1.

Fig. 6 is a schematic showing of a probe temperature and alert table similar to one maintained by the monitoring and tracking system of Fig. 1.

Fig. 7 is a schematic showing of a maximum shelf life table similar to one maintained by the monitoring and tracking system of Fig. 1.

Fig. 8 is a schematic showing of a sensor temperature and alert table similar to one maintained by the monitoring and tracking system of Fig. 1.

Fig. 9 is a side view of an exemplary food processing device that can be used in a further embodiment of the monitoring and tracking system of Fig. 1.

Fig. 10 is a schematic block diagram of a remote controller used in association with the exemplary food processing device in the embodiment of Fig. 9.

Detailed Description of the Invention

Referring to Figs. 1 and 2, a monitoring and tracking system 20 includes a portable hand-held data collector 22, a central computer 24 and a communications link 26 providing electrical communications between the data collector 22 and central computer 24. Referring to Figs. 1 and 2, the data collector comprises a main body including a pistol grip 28, a temperature sensing probe 30 electrically connected to the body 28 by a communications link 32 and a printer 34 electrically connected to the body unit 28 by a communications link 36. The main body 28 of the data collector 22 has a data processor 38, for example, an 8 bit PIC microcontroller, mounted therein. The microcontroller 38 is in electrical communication with a reader 40, for example, a bar code reader and a communications unit 42, for example, a wireless transmitter/receiver or transceiver. The transceiver 42 is a UHF, for example, a line-of-sight 900 Mhz, transceiver. In a known manner, the transceiver 42 uses two transmitters that are close in frequency, for example, 906 Mhz and 915 Mhz. The microcontroller 38 initiates communications using one transmitter; however, if a link cannot be established, the microcontroller 38 then initiates communications with the second transmitter. The output of the transmitters is amplified and filtered in an LC filter in a known manner prior to feeding an antenna. The transceiver 42 and all other transceivers in the system comply with FCC regulations.

In addition to its internal memory, the microcontroller 38 is connected to external memory 48 which normally is a nonvolatile memory such as an EEPROM. The microcontroller 38 is also in electrical communications with user input/output ("I/O") devices 44. The user I/O 44 can include a user input device, for example, a pushbutton and/or keypad 45, or an output device, for example, an audio sound generator 46, or a display 47, such as an LCD screen, etc. The keypad 45 normally has a set of keys or pushbuttons that in a known manner have alpha/numeric or functional identities.

The temperature probe 30 and the other temperature sensors identified herein may detect temperature is several different ways. For example, the temperature probe 30 may be a resistance temperature device, a thermocouple, an infrared detector, etc; however, in the described embodiment, the temperature probe 30 uses a thermocouple to detect changes in temperature of the food. An analog temperature signal from the thermocouple temperature probe 30 is amplified by an analog operational amplifier ("op amp") 54. A second op amp 56 operates with a digital to analog converter ("DAC") 58 to provide an analog signal to an analog to digital ("A/D") converter 59 that is within the range of the A/D converter 59. The operation of the DAC 58 and op amp 56 permit the relatively narrow magnitude range of the A/D converter 59 to accommodate the much wider magnitude range of the output signal from the thermocouple sensor 30. In operation, when the microcontroller 38 samples the output from the A/D converter 59 and determines that the output is saturated or at its maximum value, the microcontroller 38 provides a known value to the DAC 58 which functions to offset or reduce the magnitude of the analog signal output from the op amp 56 by a fixed amount. The microcontroller 38 again checks the output from the A/D converter 59; and if it is still at a maximum, the microcontroller 38 increments the magnitude of the signal to the DAC 58 by another fixed amount. That process continues until the microcontroller 38 detects that the output from the A/D converter 59 is no longer saturated. The microcontroller 38 then stores the output from the A/D converter 59 with the amount of offset that it provided to the DAC 58.

The microcontroller 38 then samples a temperature reading from a second temperature sensor 62 that is sensing the ambient temperature. The temperature sensor 62 can also be implemented with several known temperature detection devices, but normally the temperature sensor 62 is a temperature sensing integrated circuit device. Given the ambient temperature measurement and the measurement from the thermocouple probe 30, the microcontroller 38 calculates the temperature value of the food. The microcontroller 38 then provides commands to the transceiver 42 to transfer the calculated temperature value of the food to the central computer 24 via the communications link 26.

In response to user input commands via the user I/O 44, the microcontroller 38 operates the bar code reader 40 to read a label 49 associated with the food 50. Automatically,

at appropriate times or in response to instructions from the user via the user I/O 44, the microcontroller 38 transfers data over the communications link 26 to the central computer 24. The communications link 26 includes a remote transceiver 42, a base transceiver 41 and an ethernet hub or port 43. In addition, in response to user instructions provided via the user I/O 44, the microcontroller 38 commands the operation of the bar code label printer 34 which prints bar code labels 52 as required. The main body 28, including the user I/O 44 and bar code scanner 40, are commercially available from Symbol Technology of Holtsville, New York.

In addition to the temperature probe 30 of the data collector 22, other temperature measuring devices may be used to monitor food temperature during the food handling and preparation process. A temperature measuring device, for example, a temperature sensor, 60 is often permanently located in association with food storage device, for example, a freezer, a deep chiller, a refrigerator, etc. A sensor identical to the temperature sensor 60 may also be used to measure food temperature in a cooking pan or other container, a serving pot or bowl, or a salad bar. Temperature sensors can also be integrated within the structure of a cooking utensil, for example, a ladle or spoon. In this embodiment, the temperature sensor 60 is a thermocouple and is connected to a remote transceiver 62 via a temperature sensor conditioning circuit 61. The conditioning circuit 61 is comprised of circuits identical to the op amps 54, 56, DAC 58 and A/D converter 59 within the data collector 22 and operate as previously described. While only a single temperature sensor 60 is illustrated as being connected to the remote transceiver 62, as will be appreciated the remote transceiver 62 may be designed to be connected to and service a plurality of temperature sensors each with its own temperature sensor conditioning circuit.

The remote transceiver 62 has a PIC microcontroller, ambient temperature sensor and external memory similar to the microcontroller 38, temperature sensor 62 and memory 48, respectively. The PIC microcontroller in the transceiver 62 operates in a manner similar to microcontroller 38 previously described and thus, automatically measures the temperature of the food or other item which is in a heat conducting/radiating relationship with the thermocouple of the remote temperature sensor 60. The microcontroller in the transceiver 62, in the same manner as described with respect to the operation of the microcontroller 38, automatically transmits the measured temperature value and other data to a base transceiver 41b which, in turn, transmits the data to the central computer 24 via an ethernet hub 43. The measured temperature value is stored in the central computer 24 with a time and date stamp. In addition, with that data, the remote transceiver 62 also transmits a code identifying the transceiver 62 as well as the most recent measurement of the ambient temperature value.

The base transceiver 41b, as well as other base transceivers used in the monitoring and tracking system 20, are identical in construction. Each transceiver 41 has a PIC

microcontroller and a transceiver unit similar to the microcontroller 38 and transceiver 42 previously described. However, the base transceiver 41 also communicates with an ethernet port and in addition, has a serial communications port that may be connected to another device, for example, a printer 70. To support those additional functions, each base transceiver 41 has a second data processor or central processing unit ("CPU") and memory in electrical communications with the PIC microcontroller. The CPU manages the ethernet communications as well as managing other higher level protocols, for example, controlling the printer 70. In other locations, a temperature sensor 66 and temperature sensor conditioning circuit 67 may be connected directly to a base transceiver 41a. In this embodiment, the temperature sensor 66 is a thermocouple; and therefore, the temperature sensor conditioning circuit 67 is identical to the temperature sensor conditioning circuit 61. Further, the microcontroller in the base transceiver 41 samples a temperature value from the temperature sensor 66 and transmits that value to the central computer 24 in an identical manner as previously described with respect to the operation of the microcontroller 38.

As previously described, the transceivers 42, 62 are line-of-sight transceivers which have a relatively short range; and therefore, it may be necessary to use one or more relay devices, such as a repeater 64, to transmit signals from the temperature sensor 60 or the data collector 22 to the central computer 24. The repeater is a relatively short range RF transceiver having the same construction and operation as the transceivers 42, 62 previously described.

The monitoring and tracking system 20 facilitates the monitoring and tracking of temperatures of identifiable food items and batches of prepared foods throughout the entire food handling, preparation and serving processes within a food preparation facility. Further, the monitoring and tracking system has the capability of entering and storing every step of every process a user is expected to perform in the central computer 24. For example, at the location where food items are received from a supplier, the user may execute one or more of the following processes: check-in process number 10-standard, check-in process number 11-with no temperature, check-in process number 12-without temperature validation, check-in process number 13-deep chill temperature, etc. Further, at that location, a placard is placed that displays bar codes for each of the processes to be executed at that location. Thus, to initiate a process, the user of the data collector 22 simply scans the bar code on the placard next to the identity of the desired process; or alternatively, the user can enter the process number, for example, 10, 11, 12, 13, etc., using the keypad 45. Once a process is initiated, the user of the data collector 22 is prompted through each step of the process by messages on the visual display 47 and audible signals. Thus, the process of handling incoming food items can be predetermined in exact detail.

One embodiment of a food temperature monitoring and tracking process is illustrated in Fig. 3. Assuming the user has initiated a standard check-in process as described

above, the user is first prompted, at 302, to scan the bar code on the food package. Normally, food is received in packages that contain a UPC bar code label identifying the manufacturer, the product and its price. The user orients the body 28 of the data collector 22 such that the scanner 40 is able to read the UPC bar code label 49 on the food package 50. That information is decoded by the microcontroller 38; and the microcontroller 38 initiates a transfer of the bar code data via the remote transceiver 42, base transceiver 41a and ethernet hub 43 to the central computer 24. The information read from the UPC label 49 can be displayed to the user via the display 47.

The central computer 24 contains various tables containing the information shown in Fig. 4 which represents a list of all products that may be found at any time in the food processing facility. Thus, the computer is programmed with each bar code expected to be read, the name of the food item associated with the bar code, the food type of the food item, a digital identification code for the food item, a receiving temperature range, a default or initial storage location, if any, for the food item, an indication of whether the food item is temperature sensitive, etc. With the table of Fig. 4, the computer 24 is able to add the scanned food item to an inventory table shown in Fig. 5. The inventory table lists each food item in the food processing facility by its digital identification code and for each digital identification code, includes the food item name, the food type, its location, the initials of the person entering the data, the time and date the food item was received, the acceptable temperature range of the food being received, etc.

If there is no default storage location, the central computer 24 sends a message to the data collector 22 for display on the data collector visual display 47 asking the user where the food item is to be located. All potential locations for the food have a digital identification code which can be entered by the user with the keypad 45. Alternatively, the digital codes of the different locations can be reproduced in bar code form on a placard that is posted at the location of the user receiving and scanning the food item. Thus, the user can simply scan the bar code of the location to which the food item is to be moved. The bar code is decoded by the processor 28 and then transmitted to the central computer 24. The central computer 24 stores a table associating the decoded bar code indicia with a specific location, and the computer 24 enters the identity of the specific location into the inventory table of Fig. 5. As will be appreciated, the table of Fig. 5, as well as the other tables illustrated, are presented in human readable form; however, the computer 24 normally stores table data in machine readable code.

Next, upon a prompt from the computer 24, the user uses the probe 30 to measure the temperature of the food package 50, and that temperature value is transferred to the central computer 24 via the remote transceiver 42, base transceiver 41a and ethernet hub 43. The central computer 24 stores the measured temperature value along with a time and date stamp and the food item location in a table such as that shown in Fig. 6. The table of Fig. 6 also

contains ranges of acceptable temperature values that are dependent on the location at which the temperature measurement was taken. That temperature range information is obtained from a table of locations and acceptable ranges of temperature at those locations which has been programmed by the user and store in the computer 24.

The central computer 24, at 304, executes an HACCP analysis using the programmed the receiving temperature range in Fig. 4 to determine whether the food packages entering the facility conform to accepted temperature specifications. While not mandated, the HACCP analysis provides temperature and time specifications that are widely accepted and followed in the food handling and processing industry. If, at 305, the HACCP analysis results in detecting a nonconformance of the measured temperature with desired temperature specifications, then, at 306, an alert is activated. The alert may be audible, visual or any sensory perceptible alarm and can be activated at the central computer 24. However, normally, an alert signal is transmitted from the central computer 24 to the hand-held data collector 22; and an audible, visual or other alert signal is presented to the user of the data collector 24. For example, the computer 24 may either instruct the user to print or, directly command the printer 34 to print, a reject label. Alternatively, the computer 24 may send a message to the data collector 22 displaying the out of range reading and allow the user of the data collector 22 to make a decision. Alternately, the computer 24 may send a message to the data collector 22 to call a manager for a decision. In a further alternative, one or more of those corrective actions may be taken depending on how far out of range the measured temperature is. In addition, other alert signals may be automatically transmitted to an offsite location, for example, an office location where out-of-temperature data is monitored. As shown in Fig. 6, the system also maintains a table of alerts and the corrective action taken. If on receiving out of temperature food, a decision other than to reject the food item is made, the system requires that some entry of a corrective action be made.

The HACCP analysis, at 302, also determines an expiration date, that is, the date after which the food package should not be used. The central computer contains a shelf life table, as shown in Fig. 7, that lists all food types that may be found in inventory, all food items associated with each of the food types and the shelf life of each food type at each location in the facility. Thus, knowing the food type and location information, the computer 24 reads a shelf life value from the shelf life table and then calculates an expiration date for the food item. The expiration date is then stored in the inventory table of Fig. 5 in association with the food item.

The computer 24 then creates data for a product rotation label. The information on a product rotation label is determined in advance by the user and often contains the name of the food item, its current location, its most recent temperature, its expiration date, etc. Further, such information is in human readable and coded form, for example, bar code form, on the label. If the central computer 24 does not have all of the information required for the product rotation

label, such information is requested from the user by sending a message to the visual display 47 of the data collector 22. The data to be included on the product rotation label is then, at 307, transmitted via the ethernet hub 43, base transceiver 41a and remote transceiver 42 back to the microcontroller 38 within the portable hand-held data collector 22.

Thereafter, at 309, the computer 24 either instructs the user to print or, directly commands the printer 34 to print, the first product rotation label 52 (Fig. 2) which is then applied to the incoming food package 50. At this point, the incoming food package has been identified, entered into the system inventory, checked for temperature and assigned to its next location.

Then, at 310, the food package 50 is transferred to its destination, for example, a food processing station, a cold storage facility, etc. For purposes of this example, assume, at 312, it is determined that the food package 50 is to be transferred to a chiller. Again, the process of transferring the food package 50 with the first product rotation label to the chiller will differ from one facility to another. In one facility, the person receiving the food package may also immediately place the food package in the chiller. In other facilities, the food package 50 may be manually or automatically transported to the chiller by the same or a different person. Further, each facility may or may not have a formal process for placing the food item into the chiller. Again, if so, the process is initiated by the user of the data collector 22 manually entering a process number or scanning a bar code associated with the process. For purposes of this example, the following process is to be executed.

The person placing the food package in the chiller, at 314, uses the scanner 40 of the data collector 22 to scan the first rotating product label, thereby sending an identity of the food package 50 to the central computer 24. Next, the user of the data collector 22 enters the code identifying the chiller unit. The chiller unit will have a placard on or adjacent the unit which provides the identification code of the unit in both human readable and machine readable form. Thus, the code is entered using the keypad 45 or scanned in using the scanner 40. In either event, the chiller unit code is transferred to the central computer 24 which updates the inventory table of Fig. 5 with the new location of the food package 50.

As previously described, many of the food locations, for example, freezers, chillers, refrigerators, etc. have dedicated temperature sensors for measuring the temperature maintained by the storage unit. Further, it is assumed that the food associated with that location is being maintained at the same measured temperature. Therefore, on a periodic basis that can be individually selected for each temperature sensor, the central computer 24, at 316, requests that a remote transceiver 62 or base unit 66, as appropriate, transmit the most recently monitored temperature value to the central computer 24. That measured temperature value is then stored in a sensor temperature table, as shown in Fig. 8, that chronologically lists a digital code identifying the remote transceiver 62 or base unit 41 to which the temperature sensor 60 is

connected. Further, the table of Fig. 8 stores the port to which the temperature sensor is connected, the time and date stamp of the temperature value, the measured temperature value, the acceptable temperature range, etc.

The computer 24, at 316, performs an HACCP analysis to make sure that the handling of the food package 50 conforms to the desired temperature specifications. If, at 317, the central computer 24 determines that the temperature of the food does not conform to the desired temperature specifications, then at 318, an alert is actuated. Again, any sensory perceptible alert may be used at either or both the central computer and the data collector 22. The alert at the data collector 22 signals the user that the cold storage unit is outside temperature specifications. The computer 24 maintains, in Fig. 8, an alert acknowledgment log table identifying the corrective action taken which must be entered by the user either at the central computer 24 or using the data collector 22.

Often, a food package 50 is moved from one cold storage unit to another, for example, from a freezer to a refrigerator. To place a food item in the refrigerator, the user again scans or enters a process code for that action; and the central computer 24 provides messages via the display 47 to step the user through the process. In this example, after determining, at 312, that the food item is being moved to cold storage, the computer 24, at 311, determines whether a new product rotation label is required. The existing label on the food item was put on when the food item was put into the freezer, and therefore, a new label relating to the refrigerator location is required. The user is prompted to enter the location code for the refrigerator which is scanned in from a bar code on the refrigerator or manually entered via the keypad 45. The central computer 24 then, at 313, runs a portion of the HACCP analysis to determine a new expiration date. Knowing the expiration date of the food item in the freezer and the date that the food item was placed in the freezer, the computer 24 can determine the remaining shelf life of the food item. Next, knowing the food type and location, the computer 24 determines the shelf life of the food item at its current location from the shelf life table of Fig. 7. If the remaining shelf life is greater than the normal shelf life of the food item at its current location, that is, the refrigerator, the computer 24 then calculates a new expiration date based on the normal shelf life of the food item in a refrigerator. However, if the remaining shelf life is less than the normal shelf life, the computer 24 calculates a new expiration date based on the remaining shelf life. The computer 24 enters the new location and the new expiration date of the food item into the inventory table of Fig. 5 in association with the identification of the food item.

In addition, often the computer 24 composes a new product rotation label including the new location of the food item and the new expiration date and sends that new product rotation label to the remote data collector 22. As before, the computer 24 either commands the printer 34 to print, or instructs the user to print, a new label; and the user applies

the new product rotation label on the food package 50 either over the old product rotation label or after removing the old product rotation label. Thereafter, the process of steps 314-318 are repeated. The user, at 314, scans the new product rotation label upon placing the food item in the refrigerator, and at 316-318, temperature readings from the refrigerator are sampled and analyzed. It should be noted that the process of Fig. 3 is only illustrative in nature. Temperature measurements are continuously being sampled and analyzed for all fixed temperature sensors on all cold storage units, hot holding stations, etc.

When the user desires to make a recipe, at 319, the user enters the identity of the recipe, for example, meat stew, in the central computer 24. Again, to simplify use of the system, a placard may be placed in the facility that has codes for all the available recipes in human readable and bar code forms. The recipe code is entered manually via the keypad 45 or the scanner 40. The central computer 24, at 320, first creates a batch number for the meat stew recipe, that is, a number that uniquely identifies prepared meat stew. The computer 24 then scans the inventory table and identifies the food item ingredients of the recipe that have the oldest expiration dates, thereby reducing the probability of a loss of food through spoilage. Next, a hard copy of the recipe is printed. Printers 70 can be connected to the central computer 24 or any of the base transceivers 41 and placed at different locations within the food processing facility Thus, a user can have the recipe printed at any convenient location. With the printed recipe, a person with a remote data collector 22 selects an ingredient, for example, chicken, and goes to the location of the chicken, for example, a chiller. Then, at 322, the first product rotation label 52 on each package of chicken within the cold storage unit is scanned with the scanner 40. If, at 324, the information on the bar code label 52 does not correspond to the desired package identified by the central computer 24, no signal is given. However, when the user scans a food rotation label of chicken having an expiration date corresponding to the expiration date identified by the central computer 24, at 326, an audible signal is produced by the audio signal generator 46 which identifies that package of chicken as the one that should be used. As will be appreciated, while an audio signal is more efficient to identify the food package, the audio signal may be complemented or substituted with a visual message on the display 47.

It should be noted that each time a product rotation label is scanned, the computer 24 is always checking the expiration date to determined whether it has expired. If it does detect an expired expiration date, an alert is issued to the user via the computer 24 and/or the data collector 22. Further, the expired food item will be highlighted or otherwise identified on any screen displaying the food item. Further, the user at any time can create a listing of all food items that are about to, or have, expired.

After all of the food items required for the recipe are found, at 330, and delivered to a food processing station, the computer 24, at 332, transmits to the visual display 47 of the data

collector the instructions for using the food items to make the recipe, in this example, meat stew. Assume in this example that because of the extended cooking time for meat stew, it is desirable at this time to print and apply a new product rotation label. Therefore, at 333, the computer 24 sends a new product rotation label including the batch number for the meat stew assigned by the computer 24 and a location code of the food processing station to the data collector 22. The computer 24 may, at 334, either, directly command the printer 34 to print, or, instruct the user to print, the new product rotation label which is then placed on, or at a location adjacent, the food processing station. A dedicated temperature sensor 60 may, at 335, be used in a cooker or a utensil to measure the temperature of the meat stew being prepared. On a periodic basis, the computer 24 requests that the remote transceiver 62 transmit the most recently measured temperature to the computer for storage. The computer 24 stores the measured temperature with a time and date stamp in a table as shown in Fig. 8 of measured temperatures. Alternatively, the user may use the probe 30 of the remote data collector 22 to measure the temperature of the meat stew being prepared in addition to, or in place of, the temperature sensor 60. When the temperature is measured with the temperature probe 30 of the data collector 22, the user then scans the product rotation label containing the batch number of the meat stew and the location at which the food is being prepared. Alternatively, that information may be manually entered with the key pad 45. When using the data collector 22, the computer 24 updates the probe temperature table of Fig. 6.

At 336, the central computer 24, upon receiving each measured temperature value from the food preparation process, performs an HACCP analysis to determine whether the preparation of the meat stew corresponds to the recommended temperature specifications. If at 337, the computer 24 detects that the temperature does not conform to the temperature specifications, then at 338, an alert is sounded. Again, the alert is any sensory perceptible alert and may be presented at the computer 24, the data collector 22 or the location of the food processing station. The user is thus advised that the food being prepared is out of the desired temperature specification, and the appropriate corrective action is then taken. Again, the computer 24 may maintain a log of all of such out of range temperatures as well as the corrective action taken.

When the meat stew recipe is completed, it may, at 339, be placed in cold storage or served. If the meat stew is to go to cold storage, for example, a freezer, chiller or refrigerator, the process as previously described with respect to steps 311-318 is executed. If, at 339, it is the meat stew is to be served, the food is moved to a serving station. The data collector 22 is used to enter a process for moving the meat stew to a particular serving station, and the central computer 24 transmits messages to the data collector 22 stepping the user through the process. As part of that process, the central computer 24 determines, at 340, an

expiration date for the meat stew. As before, the shelf life for cooked food is in the shelf life table of Fig. 7, and the computer 24 uses that value to determine the expiration date for the meat stew. The computer 24 also enters the meat stew in the inventory table. In addition, the computer 24 composes a new product rotation label containing the digital code identifying the batch number of the meat stew, its serving location, the new expiration date, and the temperature at which the meat stew is to be maintained at the serving station. The new product rotation label is transmitted to the data collector 22 with, at 341, either a command to the printer 34 to print, or instructions to the user to print, a new product rotation label which the user then applies on the container holding the food or at a location adjacent the food.

At different times during the serving process, the temperature of the meat stew being served is measured and transmitted back to the computer 24. In the same manner as previously described with respect to a food preparation station, the temperature of the meat stew being served may be measured by a dedicated temperature sensor 60 or the temperature probe 30 of the data collector 22 and transmitted back to the computer 24. Further, as previously described, the central computer 24 stores the measured temperature values in the appropriate tables with a time and date stamp and other information as previously described. At 344, an HACCP analysis is performed, and if the temperature of the meat stew being served falls outside the recommended temperatures as detected at 346, an alert is activated at 348. The alert may be an audible and/or a visual alert that is activated at the food serving station, and/or the alert may be remotely located in the kitchen, and/or the alert may be activated at the central computer 24 in audible or visual form. Corrective action must then be taken to clear the alert.

The above is only one example of how the monitoring and tracking system of the present invention can be implemented. By having an accurate record of the age of all food items in inventory, the user can print a report of the food items in inventory that is sorted by expiration date. Thus, each day the user knows exactly what foods are about to exceed their shelf life and select daily recipes so that all of the oldest foods are used within their recommended shelf lives.

In another implementation, the user has the option of entering a manufacturer's lot number into the inventory table of Fig. 5. If used, the computer 24 requests the user to enter the number as part of the process of receiving a food item into inventory. Normally, the manufacturer's lot number is printed on the food item label in human readable form; and therefore, the user must enter the number using the keypad 45. Thus, if a manufacturer issues a recall of food items produced in a particular lot number, the monitoring and tracking system can be commanded to print a report that is sorted on the basis of the recalled lot number. Therefore, the user can accurately and immediately determine if there are any food items in inventory that were manufactured in the recalled lot number. If so, the user can execute a recall process with

the computer 24. As part of that process, a list of the food items having the recalled lot number can be printed, and those food items identified and removed from inventory pursuant to processes previously described. Alternatively, the computer 24 can transmit to the data collector 22 the location and item name of the food item. Therefore, the user can quickly sort through the inventory at that location and remove the desired food items. In another implementation, the user can choose to have the lot number printed on the product rotation label; and in that situation, the scanner 40 can be used to identify all food items at a particular location that have the recalled lot number.

In other situations, often food items in a recalled lot number have been used and consumed prior to the receipt of the recall notice. With manual systems, the manufacturer's lot number is often not recorded, and therefore, it is impossible to determine whether any recalled food items were received or consumed. Therefore, there is no way to verify or disprove complaints made by customers with respect to prepared foods that possibly could have been made from food in recalled lots. However, with the present invention, if complaints are received with respect to a particular prepared food, the time and date that the recipe was prepared and served can be accurately and quickly determined. In addition, the food items and the lot numbers of the food items used in the recipe can also be accurately and quickly determined. Therefore, a link between the complaint and the recalled lot of food items can be accurately and almost instantaneously established or not. The ability to accurately and quickly prove or disprove a link between a complaint and food items in a recalled lot, permits a resolution of such situations with more certainty and efficiency.

In a further embodiment, the monitoring and tracking system of the present invention can be used to track processing activity in addition to temperature. For example, the system may be used to track the operation of food processing appliances or devices, for example, mixers, fryers, cookers, coolers, etc. Further, with this embodiment of the invention, the operation of those processing devices can be controlled and monitored from a central location. In one example, referring to Fig. 9, a food processing device, for example, a mixing or stirring head, 76 is mounted on the end of an articulated arm 77 that, in turn, is attached to a surface 78. The articulated arm 77 is any device that allows the mixing head 76 to be positioned at any point within the operating envelope of the arm 77, for example, above a processing station 79 at which a container 80 is located. The container 80 contains a food, for example, food material or ingredients, 87 to be processed. The mixing head 76 has a mixing tool 81 mounted to an electric motor 82 in a known manner. The mixing tool 81 may be a whisk, paddle, scraper or any other tool required for the process being practiced at the processing station 79.

A temperature probe 83 has a sensing element disposed within the food 87 within the container 80. The temperature probe 83 is, for convenience, mounted to the motor 80. As

will be appreciated, the temperature probe 83 can be mounted in any way that facilitates the measurement of temperature within the container 80. The processing station 79 also has a heater 84 for heating the food in the container 80 as required. The operation of the motor 82 and heater 84 can be controlled locally, that is, at the processing station 79, by an operator using controls in a known manner. Many different levels of controls are known. For example, the motor 82 can have a manual switch that controls the rotational speed of the motor 82. With simpler systems, the temperature probe 83 may not be used or, may only be used to provide a warning that the food 87 has exceeded a desired temperature limit, either maximum or minimum. With more sophisticated controls, the operator may simply actuate a cycle switch; and the motor 82 and heater 84 are automatically operated over desired periods of time to maintain the food 87 at a desired temperature as measured by the temperature probe 83. With the present invention, in addition to being subject to local controls, the motor 82, heater 84 and temperature sensor 83 are connected to a remote controller 86 also mounted on the motor 82.

The remote controller 86 has a temperature sensor conditioning circuit 90 that receives an analog temperature feedback signal on the output 85 from the temperature probe 83. The temperature sensor conditioning circuit 90 has circuits identical to the operational amplifiers 50, 56, DAC 58 and A/D converter 59 (Fig. 1) within the data collector 22 and operate as previously described. The remote controller 86 has an internal control unit 93 comprising a microcontroller 92 and a CPU 98. The microcontroller 92 operates similarly to the microprocessor 38 (Fig. 1) and stores the output from the temperature sensor conditioning circuit 90 in a manner as previously described. The microcontroller 92 utilizes the output from the temperature sensor conditioning circuit 90 and an output from a temperature sensor 94 measuring ambient temperature to calculate the temperature of the food 87 (Fig. 9) within the container 80. In the same manner as previously described with respect to the microcontroller 38, the microcontroller 92 then provides commands to a transceiver 96 that functions similarly to the transceiver 42 of Fig. 1 to transfer the calculated temperature value to the central computer 24 (Fig. 1) via the communications link 26. Thus, the remote controller 86 is operative to monitor various conditions, for example, the temperature, of the food 87

The remote controller 86 also has a second data processor or CPU 98 and associated memory 100. The CPU 98 is in electrical communications with the microcontroller 92 and has a serial communications port that is connectable to communicate with external devices in a known manner. The CPU 98 is also electrically connected to an input/output ("I/O") interface 102 which, in turn, is in electrical communications with a motor control 104 and a heater control 106. Therefore, in response to commands generated by the CPU 98, the motor control 104 can be instructed to operate the motor 82 over any desirable cycle and speed within the capabilities of the motor 82 and motor control 104. The real time operation of the motor 82 in response to the

operational cycle instructions from the CPU 98 is most often executed by the motor control 104. However, as will be appreciated, motor position and motor speed feedback signals may be provided to the CPU 98 in a known manner, and the CPU 98 can be used to implement real time control of the operation of the motor 82. The CPU 98 is also used to operate the heater control 106 to cycle the heater 84 over fixed time intervals or intervals controlled by the temperature of the food 87 in the container 80 as measured by the temperature probe 83. In addition, the temperature of the heater 84 may be controlled as a function of a temperature feedback signal from a temperature sensor 99 measuring the temperature of the heater 84.

Further, as will be appreciated, in addition to or instead of local control, commands to operate the motor 82 and/or heater 84 may originate with the central computer 24 (Fig. 1) and be transmitted via an ethernet hub 43, base transceiver 41 and repeater transceiver 64, if used, to the remote controller 86 of Fig. 10. Thus, the operation at the processing station 79 can be controlled by remotely generated commands from the central computer 24. For example, if it is desired to heat the food 87 to a particular cooking temperature, the central computer 24 provides command signals to the remote controller 86 which are provided by the CPU 98 to the heater control 106, thereby turning the heater 84 on. The temperature probe 83 senses the increasing temperature of the food 87 and transmits that temperature back to the central computer 24. The central computer 24 can optionally command the motor 82 to operate the stirring device 81 at any desired speed. Further, by monitoring the temperature from the temperature probe 83, the central computer 24 can operate the heater 84 such that the food 87 in the container 80 is brought to a desired temperature over a desired period of time and thereafter, is maintained at that temperature. At the end of the cooking process, the central computer 24 provides commands to the remote controller 86 to turn the heater 84 off. It may then be required that the food 87 in the container 80 experience a cooling period. If desired, the central computer 24 can provide command signals to the remote controller 86 to operate the motor 82 so that the cooling period is facilitated by the operation of the stirring device 81. Further, during the entire cooking and cooling processes, the temperature of the food 87 is being continuously monitored by the temperature probe 83 and tracked in accordance with the process as described with respect to Fig. 3.

The ability to independently operate devices at a processing station has significant potential. For example, assume the mixing head 76 has a switch 108 that closes, or is in a first state, in response to a mixing tool 81 being inserted into the mixing head 76 and opened, or in a second state, upon the mixing tool 81 being removed from the mixing head 76. Hence, by tracking the state changes of the switch 108, the central computer 24 is able to monitor or track whether a mixing tool is mounted within the mixing head 76. Therefore, if the mixing tool 81 has not been mounted in the mixing head 76 or becomes disengaged from the mixing head

76 during operation, the central computer 24 is able to detect that fault and automatically provide an alarm or error message. Other switches, proximity detectors, photoelectric detectors, etc. may be used to monitor and track the proper operation of other appliances and processes within the system. For example, other switches may be used to detect whether a refrigerator/cooler door is open or closed. If the central computer 24 detects that such a door is open for an extended period of time, an alarm or error message can automatically be issued. Similarly, switches may be used to monitor the number of times a basket of food is loaded into and/or removed from a cooker or fryer, etc.

Further, the embodiment of Figs. 9 and 10 is highly compatible with the monitoring and tracking system described with respect to Fig. 3. For example, upon the creation of a food rotation label associated with the food 87 at the food processing station 79, the food processing device(s) 82, 84 at the food processing station 79 are started. The operation of the food processing devices may be initiated by an operator, and the operation of the food processing devices monitored by the remote controller 86 and/or central computer 24. The remote controller 86 and/or the central computer can be testing the operation of the food processing devices and the state of the food against desired operating parameters and/or desired food states. If any deviation from the desired parameters or states is detected, the central computer 24 and/or the remote controller 86 can initiate an alteration or termination of the operation of the food processes devices. Alternatively, the central computer can transmit messages to the remote data collector 22 to advise the operator of a critical situation or desired action. In another variation of this embodiment, after the food has been properly supplied to the food processing station 79, the central computer 24, via the remote controller 86, can initiate the operation of the food processing devices and monitor their operation during the food processing cycle.

Thus, this embodiment of the invention not only facilitates the monitoring and tracking capability, but also provides a remote operational capability of food processing devices that either complements or, in some applications, replaces an operational capability that is local to the food processing device. Hence, the need for ongoing maintenance of food processing devices can be monitored, and the appropriate alarms generated in response to detecting a condition that should be addressed. The alarm can be in any form, for example, the activation of a sensory perceptible warning buzzer or light, and the generation of the alarm can be stored and reported. In other applications, upon detecting an undesirable operating condition, the food processing device can be shut off from the remote computer 24. In still other applications, knowing the recipe being prepared, after food is located at various processing station, either manually or automatically, the central computer 24 can provide the commands required to operate the food processing devices at the respective food processing stations. Thus, with this embodiment of the invention, the additional monitoring and control over food processing devices

facilitates the consistent preparation of food, thereby providing a consistent, high quality food product.

The monitoring and tracking system of the present invention automatically recalculates as necessary and tracks the changing shelf life and expiration dates of all food items in inventory and at all stages of the food preparation process. Further, as food items are moved through the food handling and processing facility, the present invention permits new product rotation labels to be accurately and quickly printed on the floor at the location where the label is to be applied. Further, the label includes all pertinent information in coded as well as human readable form so that the information on the label can be accurately and quickly entered into the system by a scanning process.

In addition, as recipes are selected, the monitoring and tracking system of the present invention automatically identifies the oldest food items in inventory and their respective locations, and the system provides an accurate and efficient semiautomatic process for finding those items at their locations. Thus, the ingredients with the oldest expiration dates can be accurately and quickly found, so that food items do not spoil in inventory. This feature can completely eliminate spoilage and having to dispose of food in inventory which represents a substantial savings to the user.

Further, the monitoring and tracking system of the present invention can quickly and accurately determine whether food items associated with a manufacturer's recalled lot number have been brought into inventory. Further, the exact date those food items were used in a specific recipe and ultimately consumed can also be accurately, easily and quickly determined. Thus, the system has the advantage of accurately and quickly being able to identify recalled food items as well as accurately verify whether complaints correspond to the use of recalled food items in specific recipes on specific days. Thus, any such complaints can be expeditiously handled with a high level of confidence and certainty.

The monitoring and tracking system of the present invention has all of the above-described features in a single system that is very flexible in that the user can define any number of process steps in as few or as many processes as desired. Further, while it is important that product rotation labels contain an identity of the food item and its expiration date, the user can print any other information on the label, as desired. Further, the user has great flexibility in choosing which fields in which tables to use, and the user can adjust the HACCP analysis as desired, so that a more stringent or less stringent model is implemented. Thus, the monitoring and tracking system of the present invention provides a tool for a food handling and processing system that was heretofore unavailable.

While the present invention has been illustrated by a description of various preferred embodiments and while these embodiments have been described in considerable detail

in order to describe the best mode of practicing the invention, it is not the intention of Applicant to restrict or in any way limit the scope of the appended claims to such detail. Additional advantages and modifications within the spirit and scope of the invention will readily appear to those skilled in the art. For example, in the described embodiment, the sensors 30, 60, 66 are used to measure and track temperature. As will be appreciated, the sensors 30, 60, 66 may be used to monitor and track any other desired condition or state of an item. For example, the sensor may be used to sense pressure, force, airflow, weight, etc. Transducers capable of sensing such conditions are commercially available.

In the described embodiment, the communications link 26 is described as a RF wireless link in combination with an ethernet link or hub. As will be appreciated, either the wireless link and/or the ethernet hub can be replaced by any other known communications links, for example, a serial line, hard wiring, etc. Throughout the description, reference has been made to a single data collector as illustrated in Figs. 1 and 2, however, as will be appreciated, the monitoring and tracking system will support a plurality of data collectors 22. The monitoring and tracking system 20 is described with respect to a food processing facility. Such a facility may be a food manufacturing plant producing a packaged food, for example, dried, canned or frozen foods, for the retail or wholesale markets, a meat processing facility, a produce warehouse, a restante, etc. As will be appreciated, the monitoring and tracking system may be used in other applications unrelated to the food industry.

Therefore, the invention in its broadest aspects is not limited to the specific detail shown and described. Consequently, departures may be made from the details described herein without departing from the spirit and scope of the claims which follow.

1. A monitoring and tracking system (20) comprising:

a portable, hand-held data collector (22) comprising

a sensor (30),

a reader (40),

a user I/O device (44),

a data processor (38) in electrical communication with the sensor, the reader and the user I/O device,

a computer (24); and

a communications link (26) in electrical communications with the data processor of the hand-held data collector and the computer.

2. The monitoring and tracking system of claim 1 wherein the reader is a bar code reader.

3. The monitoring and tracking system of claim 1 wherein the sensor is a temperature sensor.

4. The monitoring and tracking system of claim 1 wherein the user I/O device includes a pushbutton.

5. The monitoring and tracking system of claim 1 wherein the user I/O device includes an alpha-numeric keypad.

6. The monitoring and tracking system of claim 1 wherein the user I/O device includes a visual display.

7. The monitoring and tracking system of claim 1 wherein the user I/O device includes an audio signal generator.

8. The monitoring and tracking system of claim 1 wherein the communications link comprises a first RF wireless transceiver in electrical communications with the data processor and a second RF wireless transceiver in electrical communications with the computer.

9. The monitoring and tracking system of claim 1 further comprising a printer (34) in electrical communications with the data processor.

10. The monitoring and tracking system of claim 9 wherein the printer is a bar code label printer.

11. The monitoring and tracking system of claim 1 further comprising:

a food processing device (76);

a temperature probe (83) adapted to measure a temperature of a food being processed by the food processing device;

a remote controller (86) located near, and in electrical communications with, the food processing device, the controller comprising

a control unit (92, 98) in electrical communications with the communications link, and

an interface circuit (108) electrically connected to the control unit and in electrical communications with the food processing device and the temperature probe.

12. The monitoring and tracking system of claim 1 further comprising:

a food processing device (76);

a remote controller (86) located near, and in electrical communications with, the food processing device, the controller comprising

a control unit (92, 98) in electrical communications with the communications link, and

an interface circuit (108) electrically connected to the control unit and in electrical communications with the food processing device; and

command signals generated by the computer and transmitted to the remote controller for operating the food processing device.

13. The monitoring and tracking system of claim 12 wherein the food processing device has an electric motor (82) and the remote controller provides command signals for operating the electric motor.

14. The monitoring and tracking system of claim 13 wherein the computer provides the commands signals via the communications link to the remote controller.

15. The monitoring and tracking system of claim 12 wherein the food processing device has a heater (84) and the remote controller provides command signals for operating the heater.

16. The monitoring and tracking system of claim 15 further comprising a temperature probe (99) adapted to measure a temperature of the heater.

17. The monitoring and tracking system of claim 12 wherein the food processing device has a switch (108) and the switch provides a feedback signal to the remote controller.

18. The monitoring and tracking system of claim 17 wherein the communications link is a RF communications link.

19. A hand-held data collector comprising:

a sensor (30);

a reader (40);

a user I/O device (44);

a data processor (38) in electrical communication with the sensor, the reader and the user I/O device, and

a transceiver unit (42) in electrical communication with the data processor, the data processor receiving information from the sensor and the reader.

20. The hand-held data collector of claim 19 wherein the reader is a bar code reader.

21. The hand-held data collector of claim 19 wherein the sensor is a temperature sensor.

22. The hand-held data collector of claim 19 wherein the user I/O device includes pushbuttons.

23. The hand-held data collector of claim 19 wherein the user I/O device includes a visual display.

24. The hand-held data collector of claim 19 wherein the user I/O device includes an audio signal generator.

25. The hand-held data collector of claim 19 further comprising a printer (34) in electrical communications with the data processor.

26. The hand-held data collector of claim 25 wherein the printer is a bar code label printer.

27. An apparatus comprising:

a food processing device (76);

a temperature probe (83) adapted to measure a temperature of a food being processed by the food processing device;

a remote controller (86) located near, and in electrical communications with, the food processing device, the controller comprising

a control unit (92, 98),

an interface circuit (108) electrically connected to the control unit and in electrical communications with the food processing device and the temperature probe, and

a first transceiver (96) electrically connected to the control unit;

a second transceiver (41a, 64) in RF communications with the first transceiver, the first and second transceivers providing an RF communications link between the control unit and the central computer;

an input device (22) providing data uniquely identifying food being processed in the food processing device; and

a central computer (24) in electrical communications with the input device and the second transceiver and adapted to be utilized by a user of the food processing device, the central computer storing data uniquely identifying food being processed in the food processing device in association with the temperature of the food being processed by the food processing device.

28. The apparatus of claim 27 wherein the food processing device has an electric motor (82) and the remote controller provides command signals for operating the electric motor.

29. The apparatus of claim 28 wherein the central computer provides the commands signals via the RF communications link to the remote controller.

30. The apparatus of claim 27 wherein the food processing device has a heater (84) and the remote controller provides command signals for operating the heater.

31. The apparatus of claim 30 wherein the central computer provides the commands signals via the RF communications link to the remote controller.

32. The apparatus of claim 27 wherein the food processing device has a switch (108) and the switch provides a feedback signal representing a state of the switch to the remote controller.

33. The apparatus of claim 32 wherein the remote controller provides the feedback signal to the central computer via the RF communications link.

34. The apparatus of claim 27 wherein the control unit comprises a microcontroller (92) and a CPU (98).

35. A method of monitoring and tracking temperatures of a food item comprising:

providing identity data identifying the food item;

measuring a temperature value of the food item with a temperature measuring device;

transmitting the temperature value of the food item to a computer; and

storing at the computer the temperature value of the food item in association with the identity data, so that a record of the temperature of the food item is maintained.

36. The method of monitoring and tracking temperatures of claim 35 wherein providing identity data further comprises:

reading with a hand-held data collector a label on the food item, the label having the identity data; and

transmitting the identity data to the computer.

37. The method of monitoring and tracking temperatures of claim 36 further comprising measuring the temperature value with a temperature measuring device in electrical communications with the hand-held data collector.

38. The method of monitoring and tracking temperatures of claim 37 further comprising transmitting the temperature value from the hand-held data collector to the computer.

39. The method of monitoring and tracking temperatures of claim 38 further comprising:

transmitting temperature related data for the food item from the computer to the hand-held data collector; and

printing a label for the food item using a printer in electrical communications with the hand-held data collector, the label containing information relating to the temperature related data.

40. The method of monitoring and tracking temperatures of claim 35 wherein providing identity data further comprises providing with the computer a tracking number identifying the food item.

41. The method of monitoring and tracking temperatures of claim 35 further comprising:

measuring the temperature value with a temperature measuring device in electrical communications with the computer; and

transmitting the temperature value from the temperature measuring device to the computer.

42. The method of monitoring and tracking temperatures of claim 41 further comprising transmitting an identity of the temperature measuring device to the computer.

43. The method of monitoring and tracking temperatures of claim 35 further comprising:

measuring a plurality of temperature values of the food item at different times with the temperature measuring device;

transmitting the plurality of temperature values of the food item to the computer; and

storing at the computer the plurality of temperature values of the food item in association with the identity data, so that a time record of the plurality of temperature values of the food item over time is maintained.

44. The method of monitoring and tracking temperatures of claim 35 further comprising:

detecting a nonconformance of the temperature value of the food item with respect to specified temperature values for the food item; and

providing an alert signal in response to detecting the nonconformance of the temperature value.

45. The method of monitoring and tracking temperatures of a food item of claim 35 further comprising:

providing a first command signal from a remote controller to a food processing device in the proximity of the remote controller to operate the food processing device;

providing a temperature feedback signal to the remote controller, the temperature feedback signal representing a measured temperature of the food being processed with the food processing device;

providing second command signals from the remote controller to the food processing device to operate the food processing device such that the measured temperature represented by the temperature feedback signal is substantially equal to a desired temperature;

transmitting the measured temperature represented by the temperature feedback signal to the computer remote; and

storing the measured temperature at the computer.

46. The method of monitoring and tracking temperatures of a food item of claim 35 further comprising:

providing a first command signal from the computer to a remote controller in the proximity of a food processing device representing a desired operation of the food processing device; and

providing the first command signal from the remote controller to the food processing device.

47. The method of monitoring and tracking temperatures of a food item of claim 46 further comprising providing a feedback signal from the food processing device to the remote controller representing an operating state of the food processing device.

48. The method of monitoring and tracking temperatures of a food item of claim 47 further comprising providing the feedback signal from the remote controller to the computer.

49. A method of monitoring and tracking temperatures of a food item comprising:

providing identity data identifying the food item;

measuring a first temperature value representing a temperature of the food item at a first location;

transmitting the first temperature value and an identity of the first location to a computer;

measuring a second temperature value representing a temperature of the food item at a second location;

transmitting the second temperature value and an identity of the second location to the computer; and

storing at the computer the first and second temperature values and identities of the respective first and second locations in association with the identity data, so that a record of the temperature of the food item at different locations is maintained.

50. A method of monitoring and tracking temperatures of a food item comprising:

providing identity data for the food item;

measuring a first temperature value representing a temperature of the food item;

transmitting the first temperature value to a computer;

measuring a second temperature value representing a temperature of the food item;

transmitting the second temperature value to a computer; and

storing at the computer the first and second temperature values in association with the identity data, so that a record of the temperature of the food item over time is maintained.

51. The method of monitoring and tracking temperatures of claim 50 further comprising measuring the first and the second temperature values at different times.

52. The method of monitoring and tracking temperatures of claim 51 further comprising measuring the first and the second temperature values at different times at one food processing station.

53. The method of monitoring and tracking temperatures of claim 51 further comprising measuring the first and the second temperature values at respective first and second food processing stations.

54. The method of monitoring and tracking temperatures of claim 51 further comprising:

detecting a nonconformance of each of the first and the second temperature values of the food item with respect to specified temperature values for the food item; and

providing an alert signal in response to detecting a nonconformance of one of the first and the second temperature values.

55. The method of monitoring and tracking temperatures of claim 51 further comprising:

measuring a plurality of first temperature values representing temperatures of the food item at a first food processing station;

transmitting the plurality of first temperature values to a computer;

measuring a plurality of second temperature values representing temperatures of the food item at a second food processing station;

transmitting the plurality of second temperature values to a computer; and

storing at the computer the plurality of the first and second temperature values in association with the identity data, so that over time a record of the temperature of the food item is maintained.

56. A method of monitoring and tracking shelf life for a food item comprising:

providing identity data identifying a food item;

identifying a first location of the food item; and

automatically determining a shelf life for the food item as a function of the identity of the first location.

57. The method of monitoring and tracking shelf life of claim 56 further comprising:

identifying another location to which the food item is moved; and

automatically determining and storing a new shelf life for the food item as a function of the first and other locations.

58. The method of monitoring and tracking shelf life of claim 56 further comprising updating a table providing shelf-life values as a function of different food items and locations.

59. The method of monitoring and tracking shelf life of claim 58 further comprising automatically determining a first date on which the food item is placed at the first location.

60. The method of monitoring and tracking shelf life of claim 59 further comprising automatically generating an expiration date for a food item as a function of a shelf-life value and the first date.

61. A method of monitoring and tracking expiration dates for a food item comprising:
providing identity data identifying a food item;
identifying a first location of the food item;
determining a first date on which the food item is placed at the first location; and
automatically determining a first expiration date for the food item as a function of the identity of the first location and the first date.

62. The method of monitoring and tracking shelf life of claim 61 further comprising:
identifying a second location to which the food item is moved;
determining a second date on which the food item is placed at the second location; and
automatically determining a new expiration date for the food item as a function of the first and second locations and the first and second dates.

63. The method of monitoring and tracking expiration dates of claim 62 further comprising iterating steps in the process of claim 42 each time the food item is moved.

64. The method of monitoring and tracking expiration dates of claim 61 further comprising automatically providing an alert in response to the new expiration date exceeding a maximum expiration date for the food item.

65. A method of monitoring and tracking expiration dates for food items comprising:

(a) receiving and storing identity data identifying food items;

(b) determining and storing a first date on which each of the food items is placed at a first location;

(c) automatically determining and storing a first expiration date for each of the food items as a function of the first location and the first date;

(d) receiving and storing data identifying a second location to which one of the food items is moved;

(e) determining and storing a second date on which the one of the food items is placed at the second location; and

(f) automatically determining and storing a new expiration date for the one of the food items as a function of the data identifying the first and second locations and the first and second dates.

66. The method of monitoring and tracking expiration dates of claim 65 further comprising iterating steps (e) and (f) each time one of the food items is moved to a new location.

67. The method of monitoring and tracking expiration dates of claim 65 further comprising automatically providing an alert in response to the new expiration date exceeding a maximum expiration date for the one of the plurality of food items.

68. The method of monitoring and tracking expiration dates of claim 65 further comprising:

automatically reviewing expiration dates for all of the food items having first identity data in response for a request to use a food item having the first identity data;

automatically identifying a food item having an oldest expiration date; and

automatically providing an output identifying a location of the food item having the oldest expiration date.

69. The method of monitoring and tracking expiration dates of claim 68 further comprising:

receiving input data corresponding to the food item having the oldest expiration date; and

automatically providing an output signal in response to receiving the input data corresponding to the food item having the oldest expiration date.

70. A method of monitoring and tracking a food lot number for a food item comprising:

providing and storing in a monitoring and tracking system identity data identifying food items and food lot numbers associated with respective ones of the food items, each food lot number identifying a specific lot from which the food item was made by a particular manufacturer; and

generating a report using the monitoring and tracking system to identify the food items associated with a lot number input by a user.

71. The method of monitoring and tracking a food lot number of claim 70 further comprising:

providing and storing a plurality of location codes representing respective locations at which each of the food items has been located in food handling and preparation processes; and

automatically generating a report using the monitoring and tracking system to identify locations of the food items associated with a lot number input by a user.

72. The method of monitoring and tracking a food lot number of claim 70 further comprising:

providing and storing prepared food codes representing foods prepared using the food items; and

automatically generating a report using the monitoring and tracking system to identify prepared foods using food items associated with a lot number input by a user.

73. A method of processing a food comprising:

storing at a central computer data uniquely identifying food being processed in a food processing device;

providing a first command signal from a remote controller to the food processing device to operate the food processing device;

providing a temperature feedback signal to the remote controller, the temperature feedback signal representing a measured temperature of a food being processed with the food processing device;

providing second command signals from the remote controller to the food processing device to operate the food processing device such that the measured temperature represented by the temperature feedback signal is substantially equal to a desired temperature;

transmitting the measured temperature represented by the temperature feedback signal from the remote controller to the central computer remote from the food processing device via an RF communications link; and

storing the measured temperature at the central computer in association with the data uniquely identifying the food being processed in the food processing device.

74. The method of processing food of claim 73 wherein the food processing device is a heater and the method further comprises providing command signals from the remote controller for turning the heater on and off.

75. The method of processing food of claim 73 wherein the food processing device is a motor and the method further comprises providing command signals from the remote controller for turning the motor on and off.

76. The method of processing food of claim 73 further comprising providing the first command signals from the central computer to the remote controller via the RF communications link.

77. The method of processing food of claim 73 further comprising providing the second command signals from the central computer to the remote controller via the RF communications link.

78. The method of processing food of claim 73 further comprising:

providing a switch in association with the food processing device; and

providing a feedback signal from the switch to the remote controller representing a state of the switch.

79. The method of processing food of claim 78 transmitting the feedback signal representing a state of the switch from the remote controller to the central computer via the RF communications link.

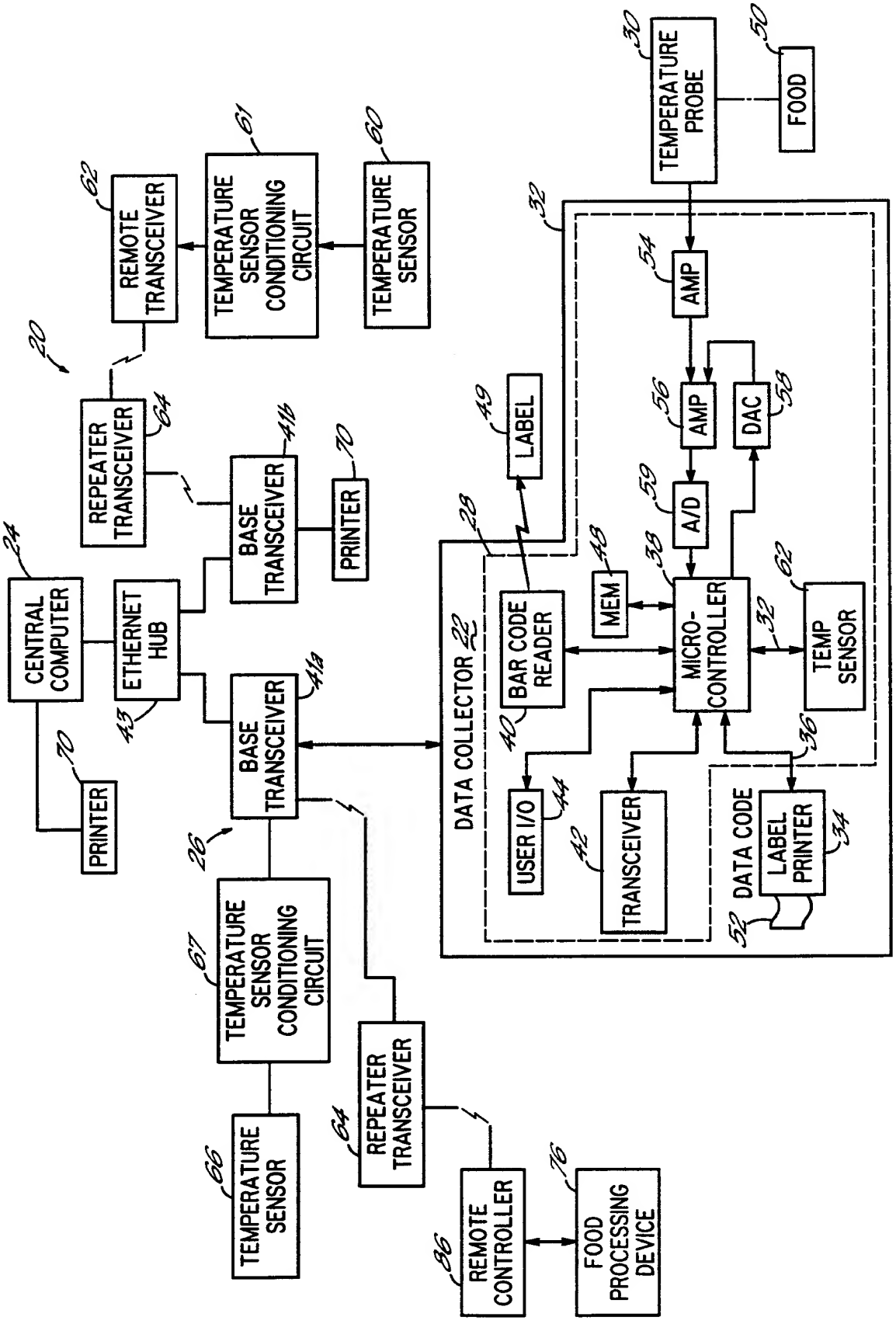
TEMPERATURE PROBE
30
FOOD
50
REMOTE TRANSCEIVER
62
TEMPERATURE SENSOR CONDITIONING CIRCUIT
61
TEMPERATURE SENSOR
60
20
REPEATER TRANSCEIVER
64
BASE TRANSCEIVER
41B
PRINTER
70
CENTRAL COMPUTER
24
ETHERNET HUB
43
BASE TRANSCEIVER
41A
PRINTER
70
26
TEMPERATURE SENSOR CONDITIONING CIRCUIT
67
TEMPERATURE SENSOR
66
REPEATER TRANSCEIVER
64
REMOTE CONTROLLER
86
FOOD PROCESSING DEVICE
76
DATA COLLECTOR
22
32
AMP
54
LABEL
49
AMP
56
DAC
58
A/D
59
28
MEM
48
BAR CODE READER
40
MICRO-CONTROLLER
38
32
TEMP SENSOR
62
36
USER I/O
44
TRANSCEIVER
42
DATA CODE
LABEL PRINTER
34
52

FIG. 1

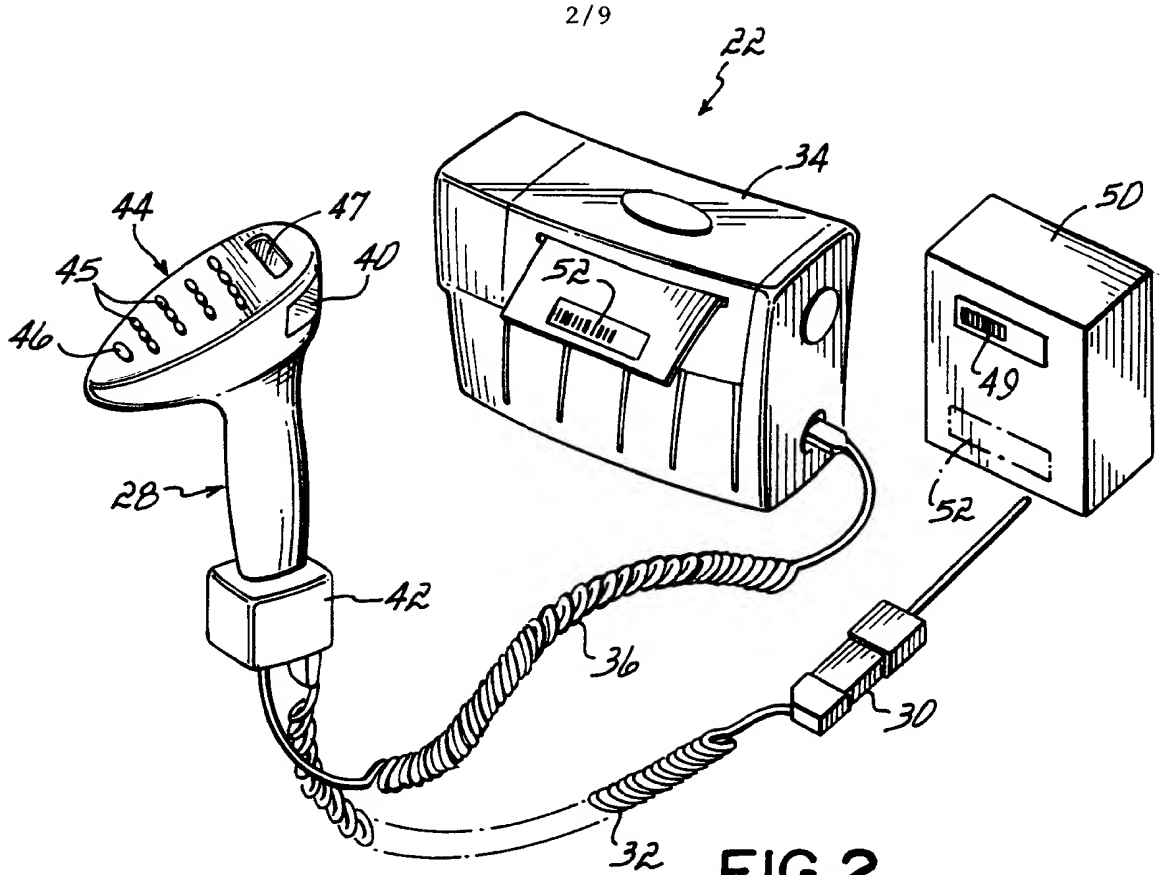

FIG. 2

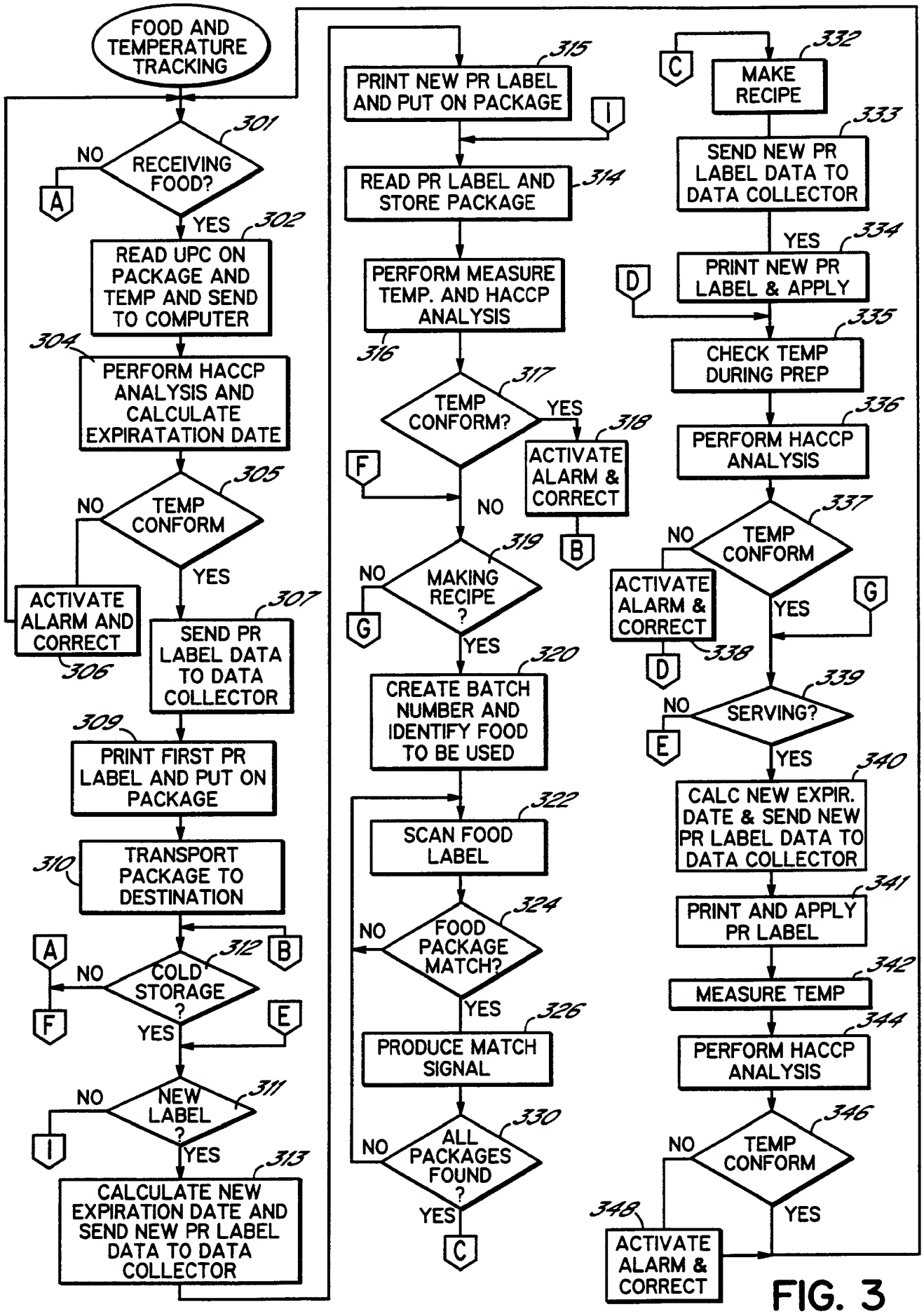
FOOD AND TEMPERATURE TRACKING
301
RECEIVING FOOD?
NO
A
YES
302
READ UPC ON PACKAGE AND TEMP AND SEND TO COMPUTER
304
PERFORM HACCP ANALYSIS AND CALCULATE EXPIRATATION DATE
305
TEMP CONFORM
NO
YES
ACTIVATE ALARM AND CORRECT
306
307
SEND PR LABEL DATA TO DATA COLLECTOR
309
PRINT FIRST PR LABEL AND PUT ON PACKAGE
310
TRANSPORT PACKAGE TO DESTINATION
A
B
312
COLD STORAGE ?
NO
F
YES
E
311
NEW LABEL ?
NO
I
YES
313
CALCULATE NEW EXPIRATION DATE AND SEND NEW PR LABEL DATA TO DATA COLLECTOR
315
PRINT NEW PR LABEL AND PUT ON PACKAGE
I
314
READ PR LABEL AND STORE PACKAGE
PERFORM MEASURE TEMP. AND HACCP ANALYSIS
316
317
TEMP CONFORM?
YES
318
ACTIVATE ALARM & CORRECT
B
F
NO
319
MAKING RECIPE ?
NO
G
YES
320
CREATE BATCH NUMBER AND IDENTIFY FOOD TO BE USED
322
SCAN FOOD LABEL
324
FOOD PACKAGE MATCH?
NO
YES
326
PRODUCE MATCH SIGNAL
330
ALL PACKAGES FOUND ?
NO
YES
C
C
332
MAKE RECIPE
333
SEND NEW PR LABEL DATA TO DATA COLLECTOR
YES
334
PRINT NEW PR LABEL & APPLY
D
335
CHECK TEMP DURING PREP
336
PERFORM HACCP ANALYSIS
337
TEMP CONFORM
NO
ACTIVATE ALARM & CORRECT
D
338
YES
G
339
SERVING?
NO
E
YES
340
CALC NEW EXPIR. DATE & SEND NEW PR LABEL DATA TO DATA COLLECTOR
341
PRINT AND APPLY PR LABEL
342
MEASURE TEMP
344
PERFORM HACCP ANALYSIS
346
TEMP CONFORM
NO
YES
348
ACTIVATE ALARM & CORRECT

FIG. 3

PRODUCT LIST

Food Item	Bar Code	Food Type	Category	Range °F	Item ID	Location
Chicken	123003	Meat	Temperature Sensitive	33-38	TT3068TT	Cooler
Broiler Paper	137201	Non-Food	Non Food - Single		TT5059TT	Store Room
English Muffin	400714	Bakery Goods	Dry Goods - Single		TT5016TT	Cooler
Beef Patties	123001	Meat	Temperature Sensitive	33-38	TT5062TT	Freezer
Fish	123002	Meat	Temperature Stensitive	33-38	TT5063TT	Freezer
Frito Lay Chee-tos	111284	Dry Food	Dry Goods - Single		TT5044TT	Store Room
Frito Lay Doritos	222284	Dry Food	Dry Goods - Single		TT5045TT	Store Room
Frito Lay Ruffles	333284	Dry Food	Dry Goods - Single		TT5046TT	Store Room
Mayonnaise	100413	Canned Goods	Dry Goods - Splitable		TT5047TT	Store Room
Mayonnaise (2)	141335	Canned Goods	Dry Goods - Single		TT5049TT	Store Room
Napkins	123034	Non-Food	Non Food - Single		TT5024TT	Store Room
Onions	123030	Fresh Food	Dry Goods - Single		TT5025TT	Cooler
Paper Cups	123033	Non-Food	Non Food - Single		TT5026TT	Store Room
Pepper	123012	Dry Food	Dry Goods - single		TT5034TT	Store Room
Perdue Breast Fillet	172745	Meat	Temperature Sensitive	33-38	TT5057TT	Cooler
Tyson Breast Fillet	111237	Meat	Temperature Sensitive	33-38	TT5061TT	Freezer
Plastic Knives	111450	Non-Food	Non Food - Single		TT5053TT	Store Room

FIG. 4

			FOOD INVENTORY				
Item ID	Name	Food Type	Expiration Date	Location	User	Received	Lot No.
TT3068TT	chicken	meat	06/15/2000 10:44:11 AM	Cooler	GRT	05/30/2000 08:24:46AM	YUI44
TT5059TT	Broiler Paper	Non-Food	04/28/2001 05:49:39 PM	Store Room	GRT	02/28/2001 05:49:39 PM	
TT5016TT	English Muffin	Bakery Goods	04/28/2001 05:50:05 PM	Cooler	GRT	02/28/2001 05:50:05 PM	ML223
TT5062TT	Beef Patties	Meat	07/26/2000 05:49:10 PM	Freezer	GRT	05/26/2000 05:49:10 PM	YU142
TT5063TT	Fish	Meat	04/27/2001 05:50:50 PM	Freezer	GRT	02/27/2001 05:50:50 PM	YU140
TT5044TT	Frito Lay Chee-tos	Dry Food	04/27/2001 05:49:16 PM	Store Room	GRT	02/27/2001 05:49:16 PM	ML224
TT5045TT	Frito Lay Doritos	Dry Food	04/27/2001 05:49:21 PM	Store Room	GRT	02/27/2001 05:49:21 PM	ML225
TT5046TT	Frito Lay Ruffles	Dry Food	05/17/2000 05:50:00 PM	Store Room	GRT	03/17/2000 05:50:00 PM	ML226
TT5047TT	Mayonnaise	Canned Goods	05/17/2000 05:50:32 PM	Store Room	GRT	02/17/2000 05:50:32 PM	ML227
TT5049TT	Mayonnaise (2)	Canned Goods	07/26/2000 05:51:54 PM	Store Room	GRT	05/26/2000 05:51:54 PM	ML228
TT5024TT	Napkins	Non-Food	04/28/2001 05:49:31 PM	Store Room	GRT	02/28/2001 05:49:31 PM	
TT5025TT	Onions	Fresh Food	04/28/2001 05:51:15 PM	Cooler	GRT	02/28/2001 05:51:15 PM	
TT5678TT	Meat Stew	Cooked Food	05/17/2000 05:50:00 PM	Soup Pot	GRT	05/17/2000 01:50:00 PM	

Fig. 5

		PROBE TEMPERATURE AND ALERT LOG			
Station Name	Sample Time	Temp °F	Range	User	Clear
Receiving	05/30/2000 08:24:46AM	30	28-33	RET	
Salad Bar	04/20/2001 05:49:26PM	91	80-90	RET	
Self Serve Soup	04/20/2001 04:21:15PM	150	165-200	RET	
		ALERT AKNOWLEDGEMENT LOG			
Station Name	Sample Time	Temp °F	Range	User	Action
Salad Bar	04/20/2001 05:49:26PM	91	80-90	RET	Replaced Probe
Self Serve Soup	04/20/2001 04:21:15PM	150	165-200	RET	
Receiving	05/30/2000 08:24:46AM	30	28-33	RET	

Fig. 6

			MAXIMUM SHELF LIFE			
Name	Descripton	Frozen	Deep Chill	Refrigerator	Hot Holding	Dry Storage
Fresh Meat	Chicken, Beef	90 days	20 days	10 days	4 hours	4 hours
Dairy	Milk, Cheese	15 days	15 days	10 days	1 hour	1 hour
Frozen Vegetables	PrePackaged	180 Days	1 Day	1 Day	4 Hours	4 Hours
Bakery Goods	Breads, Rolls	30 Days	10 Days	10 Days	4 Hours	4 Hours
Non-Food	Paper Products	366 Days	366 Days	366 Days	366 Days	366 Days
Deli Salad	Tuna/Egg Salad	5 Days	5 Days	3 Days	4 Hours	4 Hours
Fresh Fruit	Fresh Produce	4 Hours	7 Days	7 Days	4 Hours	7 Days
Cooked Food	Production Items	30 Days	7 Days	5 Days	4 Hours	4 Hours
Dry Food	Salt, Pepper	90 Days	90 Days	90 Days	4 Hours	90 Days
Canned Goods	Canned, Unopened	4 Hours	365 Days	365 Days	4 Hours	365 Days

Fig. 7

			SENSOR TEMPERATURE AND ALERT LOG				
Sentry ID	Sensor	Name	Sample Time	Temp °F	Range	Clear	
TTP106TT	1	1061	04/20/2001 05:49:26PM	90	80-90		
TTP107TT	2	1072	04/22/2001 03:15:47 PM	88.5	65-75		
			ALERT AKNOWLEDGEMENT LOG				
Sentry ID	Sensor	Name	Sample Time	Temp °F	Range	User	Action
TTP106TT	1	1061	04/20/2001 05:49:26PM	90	80-90	RET	FIXED
TTP107TT	2	1072	04/22/2001 03:15:47PM	88.5	65-75	RET	FIXED
TTP108TT	2	1082	04/20/2001 05:46:46PM	87.1	65-75	RET	PLUGGED IN
TTP109TT	2	1092	04/20/2001 05:53:30PM	90.6	65-75	RET	FIXED
TTP110TT	2	1102	04/20/2001 05:45:28PM	86	65-75	RET	PLUGGED IN
TT111TT	1	1111	04/20/2001 06:01:01PM	89.6	65-75	RET	PLUGGED IN

Fig. 8

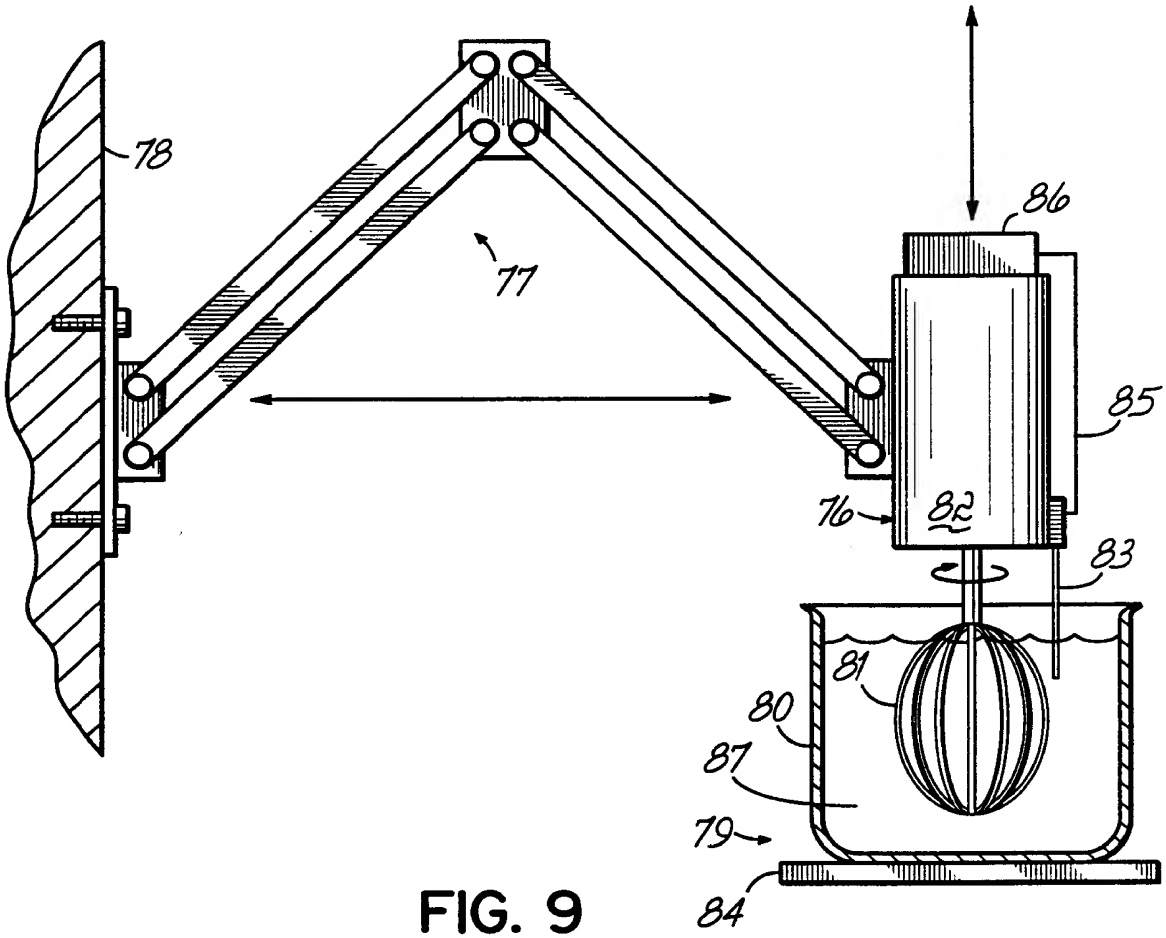
78
77
86
85
76
82
83
81
80
87
79
84

FIG. 9

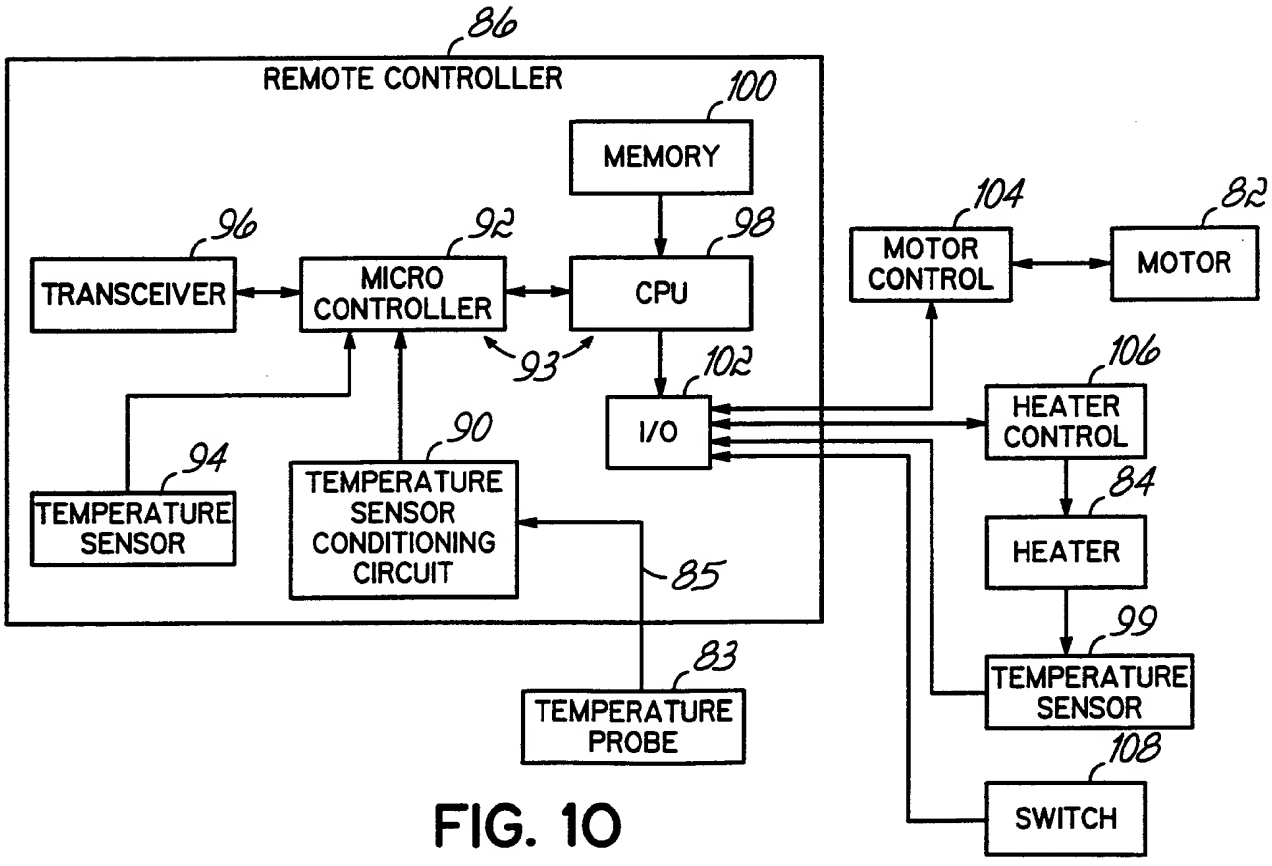
86
REMOTE CONTROLLER
100
MEMORY
96
TRANSCEIVER
92
MICRO CONTROLLER
98
CPU
93
102
I/O
94
TEMPERATURE SENSOR
90
TEMPERATURE SENSOR CONDITIONING CIRCUIT
85
83
TEMPERATURE PROBE
104
MOTOR CONTROL
82
MOTOR
106
HEATER CONTROL
84
HEATER
99
TEMPERATURE SENSOR
108
SWITCH

FIG. 10